REMARKS

Before discussing the issues raised by the examiner in the office action dated June 28, 2002, applicant first wishes to thank the examiner for the courtesy extended to the below signed attorney during the interview on August 27, 2002. It was suggested by the below signed attorney during the interview that the outstanding prior art rejections can be overcome by limiting the deformation which occurs with respect to the thickness of the strip, to the amount mentioned in the specification on page 2, lines 15-18. Accordingly, all of the pending claims and all of the new claims which are added by this amendment require that the deformation expressed by the ratio of the strip thickness before and after deformation is less than 10%. Thus, regardless of the amount of overall deformation which occurs in the process which is utilized, the reduction in the strip thickness cannot exceed the amount mentioned above. As noted during the interview, the benefits of the present invention are obtained by the annealing step which immediately follows the perforating of the strip using a continuous process. It is this annealing step which produces the desired recrystallized microstructure in the deformed portions of the strip.

During the interview the examiner raised the possibility of citing U.S. patent no. 6,342,110 as a prior art reference. Applicant submits that the '342 patent does not qualify as a prior art reference under 35 U.S.C. § 102. In this regard it is to be noted that the '110 patent issued after the filing date of the present application. Thus, the reference may not be applied under 35 U.S.C. § 102(b).

In addition, 35 U.S.C. § 102(a) does not apply. In this regard the examiner's attention is directed to the last paragraph of MPEP § 706.02(a) wherein it is stated that

"For 35 U.S.C. 102(a) to apply, the reference must have a publication earlier in time than the effective filing date of the application, and must not be applicant's own work."

35 U.S.C. § 102(c) and (d) obviously do not apply to the facts in this application.

The '110 patent does not anticipate the claimed invention. Thus, at best the examiner can only rely upon the '110 patent in a rejection based on 35 U.S.C. § 103. However, 35 U.S.C. § 103(c) provides that subject matter developed by another person, which qualifies as prior art only under subsections (e), (f), and (g) of § 102 shall not preclude patentability where the subject matter and the claimed invention were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person.

The above-noted portion of 35 U.S.C. § 103 applies to the present application since it was filed on May 26, 2000 which is after the date that 35 U.S.C. § 103(c) became effective with respect to subsections (e), (f), and (g) of 35 U.S.C. § 102 (i.e., after November 29, 1999). Furthermore, applicant submits that the '110 patent is not available as a prior art reference since the subject matter of the '110 patent and the presently claimed invention were, at the time the invention was made, owned by Integran Technologies Inc. or were subject to an obligation of assignment to Integran Technologies Inc.

Claim 1 has been amended to more particularly define the above-noted features of the invention.

Turning now to the rejections, the examiner has rejected claim 13 as being indefinite because step (i) in claim 1 is immediately followed by an annealing step which excludes any intervening step. In response to this rejection applicant has amended claim 13 so that it now recites that the recited quenching takes place following step (ii).

The examiner has rejected claims 1-16 under 35 U.S.C. § 103 as being unpatentable over Abdel-Reihim et al. in view of Tilman et al. or Myers. In rejecting the claims the examiner notes that the features relied upon in the rejection can be found in the abstract of the Abdel-Reihim et al. reference. However the examiner acknowledges that Abdel-Reihim et al. do not disclose the recrystallization conditions and special grain boundary percentage. The examiner turns to the secondary references for this aspect of the invention. In this regard the examiner urges that Tilman et al., in the paragraph bridging columns 1 and 2, and Myers, in column 3, line 27 to column 5, line 12, disclose recrystallization conditions for lead alloys in the same field of endeavor or an analogous metallurgical art. Accordingly, the examiner concludes that it would be obvious for one skilled in the art to adapt the lead alloy crystallization conditions as taught by Tilman et al. or Myers in order to improve or provide the lead alloy properties. Applicant has carefully considered this rejection but it is most respectfully traversed for the reasons discussed below.

The recrystallization conditions taught by the two cited secondary references both require metal working to achieve <u>a reduction in thickness which exceeds 10%</u>. For example, Tilman requires a thickness reduction of about 67% <u>or greater</u> (see column 1, lines 11-17 and claim 1, lines 3-4). In contrast, the total thickness deformation which occurs in applicant's claimed invention is less than 10%.

Similarly, Myers et al. also requires more than 10% reduction in thickness. In particular, the passage noted by the examiner (column 3, line 27 to column 5, line 12) requires reducing the thickness of the metal strip by passing it through successive rolls wherein each roll in succession reduces the thickness by about 25% (column 3, lines 35-40). It is further stated that the total thickness reduction is about 90% which is achieved by multiple successive reductions of about 25% each (see column 4, lines 5-7).

The abstract of the primary reference (Abdel-Reihim) relied upon by the examiner states that deformation may be used to strengthen the lead alloys. However, it is clear that applying the thickness reductions required by the secondary references to the process described by the primary reference, will not result in applicant's invention in view of the excessively high thickness reductions required by both of the secondary references.

In addition to the above, it is to be further noted that Abdel-Reihim's paper investigates the structure and mechanical properties of lead alloys for use as expanded grids after deformation and recrystallization treatment of the strip. The investigation focuses on strengthening (=enhancing the hardness) of Pb-Sb and Pb-Ca strip to render it suitable for use on a perforation line. For instance the authors report (p 408, col 1, 29-35) that the strip needs to have a minimum hardness of over 12 Vickers (over 5,500psi) to render it suitable for processing on an expander line. The authors go on and state that to achieve the required hardness, the Sb content needs to be over 2.5%. The entire paper deals with casting a slab of Pb-Sb or Pb-Ca and deforming it on a rolling line by up to 95%. The various figures depict the Vickers hardness as function of the strip deformation expressed in % thickness reduction, indicating that typically

25-50% deformation is required to enhance the hardness. (e.g. Fig 1 for Pb-1.5Sb, and Fig 3 shows the beneficial effect of Ag additions to Pb-1.5Sb). No heat treatment whatsoever is performed on the strip and the authors don't even concern themselves with the expansion process. The "thermal investigation" solely focuses on the cooling rate during slab casting, in other words, the time it takes for the cast slab using the alloy melt to solidify and cool down to room temperature before entering the rolling process. The authors use two cooling rates, a fast one, represented by air-cooling and a slow one, represented by gradual cooling of the test specimen in a convection oven. In the case of Pb-Ca they conclude that slow cooling does not result in an increased hardness of the strip, whereas fast air cooling increases the strip hardness in the subsequent rolling deformation (Figure 8).

Figure 10 compares the fast versus slow cooling for Pb-Sb and Pb-Ca slabs after subsequent rolling deformation and the authors conclude that the reduction in grain size obtained with rapid cooling accounts for the behavior observed.

With respect to recrystallization the authors report that Pb recrystallizes below room temperature, which adversely affects the hardness and conflicts with the improvements desired and achieved by rolling deformation (p 408, col 1, 10-18).

They also only observe partial recrystallization, if any at all, and report that the degree of recrystallization in the Pb-1.5Sb-0.1%Ag rolled strip increases with the degree of deformation and the grain size decreases accordingly accounting for the lower hardness values observed between 30% and 80% deformation (p 409, col 1, 12-18 and Figure 4).

Abdehl-Reihim does clearly not use the perforation (expansion/punching) as deformation followed by an immediate heat treatment as this application nor use heat treatments to affect recrystallization after deformation.

It is respectfully submitted that Abdel-Reihim does not disclose nor concern himself with any heat treatment to affect recrystallization of a rolled lead strip or a perforated current collector. Abdehl-Reihim relies on the cooling rate used to solidify the molten alloy to a cast slab prior to the rolling treatment to adjust the grain size and hardness of the material. Abdehl-Reihim's (as Tilman or Meyers) objective is to minimize grain size reduction, minimize recrystallization of the material and optimize the rolling reduction to maximize the hardness of the strip required for subsequent processing in a perforation line which all authors agree on requires over 5,500 to 6,000 psi UTS (VHN > 12).

As noted above, both of the secondary references require deformation of the thickness to result in a substantial reduction in thickness which exceeds the 10% limitation recited in applicant's claims.

Tilman in the paragraphs bridging col 1 and 2 describes a strip treatment, which comprises hot rolling the strip five times at 125-175°C with a 20% deformation per step and then completes the process with a finish-rolling step. This process of hot rolling the strip is totally different from a mild cold deformation by perforation (expansion, punching) of less than 10% followed by a heat treatment and does not yield similar properties (see table 1 of specification).

Similarly, Meyers in the col 3, 27 to col 5, 12 discloses several cold and hot rolling steps providing at least a 25% deformation per step and an overall deformation of 95% followed by a heat treatment to age harden the strip, in other words R-R-R..HT of the strip before submitting the so processed strip to an expander/punching line.

The examiner notes in paragraph 11 on page 5 of the office action that the claimed processing steps are overlapped by the cited references. Applicant most respectfully disagrees with the examiner on this point. Unlike all the cited references, the present application focuses on using the perforation (e.g., expansion) as the deformation treatment, immediately followed by a heat-treatment to obtain a GBE structure. None of the prior art references disclose a perforation/heat-treatment combination and all the various processes of the references cited, as evidenced in example 1, table 1 of applicant's specification, do not yield a special grain boundary in excess of 50%. As table 1 in applicant's specification indicates, only perforation (Ex) followed by immediate heat treatment (Ht) improves the corrosion properties. In contrast, the process shown in the fourth column of table 1 which uses the process steps of casting, rolling, and heat treatment followed by expansion deformation (CRHTEx), which represents Tilman and Myers, does not improve the corrosion resistant properties of the metal. In this regard the Fsp values of table 1 should be noted: CREx (cast/roll followed by expansion deformation) produces a special grain boundary (F_{sp}) of only 15% whereas this same process followed by a heat treatment (CRExHT) has an F_{sp} of 81%. In contrast the process of Myers and Tilman which is shown in column 4 of table 1 (CRHTEx) has an F_{sp} of only 37%. The above-noted process of Tilman and Myers when followed by a heat treating step after expansion produces an F_{sp} of 65%. Thus, it is clear that the processes are not the same nor do they overlap. In addition, the mechanical and chemical properties are not the same and the F_{sp} counts are not the same

for Tilman, Myers and applicant's invention.

The examiner has rejected claims 1-16 under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-3 of U.S. Patent No. 6,086,691 (Lehockey et al.) in view of the abstract of JP 406267544 (Yasuda et al.) or Rao et al. Applicant has carefully considered this rejection but it is most respectfully traversed for the reasons discussed below.

Lehockey et al. do not disclose or suggest limiting the thickness reduction to an amount which is less than 10%. In fact, Lehockey et al. require in claims 1-3 that the thickness reduction should be from 30% to 80%. Accordingly, applying the battery grid technology disclosed by the secondary references to the process required by Lehockey et al. will not result in the presently claimed invention. Furthermore, even if the two secondary references utilize a process in which thickness reduction is kept below 10%, it would not be obvious to apply this teaching to the requirements of Lehockey et al. since a critical feature of Lehockey et al. requires a thickness reduction of from 30% to 80%. Accordingly, modifying Lehockey et al. to require less than a 10% thickness reduction would destroy a critical feature of the primary reference.

It is also to be noted that the heat treatment steps disclosed by the two secondary references are merely for curing the paste. Yashuda's heat treatment is a "curing step" after expansion and <u>after pasting</u> and Rao does not disclose any heat treatment other than the curing step. In contrast, the heat treatment according to claims 1-16 occurs immediately after the perforation step which uses a continuous process which results in deformation. Clearly, heat treatment which occurs after a pasting step is not a heat treatment performed immediately after the aforementioned perforating step.

Furthermore, the heat treatment in applicant's invention is for annealing the perforated strip to yield a recrystallized microstructure in the deformed portions of the strip. In contrast, the curing heat treatment of the secondary references is merely for curing the paste. One skilled in the art would readily recognize that temperatures required for annealing would have an adverse effect on the paste, which are water based, since pastes cannot take such high temperatures without unwanted drying. Furthermore, claims 20-35 specifically require that the annealing step is performed prior to pasting. In addition, claim 19 specifically requires an annealing temperature which is between 100 and 300°C. Obviously, such an annealing temperature which is at or above the boiling point of water will clearly produce an unwanted drying effect on the water based paste.

In view of the above, applicant submits that the present claims are not obvious over claims 1-3 of Lehockey et al. combined with the above-noted secondary references.

Applicant would like to take this opportunity to clarify the record in the present application. In this regard it is to be noted that there is a typographical error in the sixth line of the third paragraph on page two of the amendment dated April 11, 2002. In particular, the phrase "the prior art methods do not yield $F_{sp} < 50\%$" should read "the prior art methods do not yield $F_{sp} > 50\%$".

Also, in the amendment dated April 11, 2002, page 12 was replaced with a new page 12 comprising claims 1-7. It is believed that claim 8 was also on original page 12, but it was clear that there was never any intention to delete claim 8 from the application. In fact, the examiner correctly noted in the present office action that

claims 1-17 are pending in the application. Applicant submits that the examiner's statement concerning the pending claims is accurate. However, if this is not the case, the examiner is authorized to enter an examiner's amendment or take other appropriate action to reestablish the pendency of claim 8.

In view of the above arguments and further amendment to the claims, applicant respectfully requests reconsideration and allowance of all the claims which are currently pending in the application.

Attached hereto is a marked-up version of changes made to the application by this amendment. The attachment is captioned "Version with Markings to Show Changes Made".

Respectfully submitted,

Joseph DeBenedictis
Registration No. 28,502

Date: October 18, 2002

BACON & THOMAS
625 Slaters Lane, Fourth Floor
Alexandria, Virginia 22314
Phone: (703) 683-0500
S:\Producer\jdb\Ridout & Maybee\Tomantschger 579531\Amend 01.wpd

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

The below claims were amended as follows:

1. (Twice amended) A method of manufacturing a metallic current collector for use in an electrochemical or galvanic cell, comprising the steps of:

(i) perforating a solid, flat metal strip using a continuous process that results in deformation of the strip at least locally near the perforations, wherein said deformation expressed by the ratio of the strip thickness before and after deformation is less than 10%; and

(ii) immediately following step (i), annealing the perforated strip at a temperature below the melting point of said metal or metal-alloy to yield a recrystallized microstructure [therein] in deformed portions of the strip.

13. (Amended) A method according to claim 1, further comprising the step, following step [(i),] (ii), of quenching said perforated strip.